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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/773,821	02/05/2004	Bart van Schravendijk	NOVLP037C1/NVLS-000519C1	8057

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EXAMINER

DOLAN, JENNIFER M

ART UNIT PAPER NUMBER

2813

DATE MAILED: 06/14/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/773,821

Applicant(s)

SCHRAVENDIJK ET AL.

Examiner

Jennifer M. Dolan

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 05 April 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-8 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-8 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 05 February 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-4 and 6-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,635,583 to Bencher et al. in view of U.S. Patent No. 6,316,167 to Angelopoulos et al (cited by applicant).

Regarding claims 1, 6, and 8, Bencher discloses a method of fabricating an anti-reflective layer (15; figures 1-4) of a dual damascene device (figure 4) in a chemical vapor deposition chamber (column 9, line 60 – column 10, line 20), comprising the steps of: forming a low-k dielectric layer (14, 18; column 2, lines 42-48) on a semiconductor substrate (12) that is to be patterned; forming an anti-reflective layer (15) over the first layer (figures 1-4), wherein the antireflective layer comprises substantially no nitrogen (SiC contains substantially no nitrogen), depositing and patterning a photoresist layer (19) that contacts the antireflective layer (figures 1-4), thereby patterning the low-k dielectric layer to form interconnect line regions (figures 1-4); and forming a conductive layer (20) in the interconnect line regions.

Bencher fails to disclose that the antireflective layer comprises about 20-80% oxygen, such that the extinction coefficient is between about 0 and 1.3 at 248 nm.

Angelopoulos discloses an antireflective layer formed of oxygenated SiC, where the oxygen composition intersects the claimed range (see column 8, lines 10-25), thus forming a film having an extinction coefficient between 0 and 1.3 at 248 nm (see column 10, lines 20-35).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the antireflective layer of Bencher, such that it comprises 20-80% oxygen, as suggested by Angelopoulos. The rationale is as follows: A person having ordinary skill in the art would have been motivated to provide 20-80% oxygen to the SiC antireflective layer of Bencher, because Bencher teaches that the fundamental desired properties for an antireflective layer include a low dielectric constant, minimization of undesired reflections, high etch selectivity with respect to typical low-k or damascene materials, and simple manufacturability (see Bencher, column 7, lines 20-45), and Angelopoulos teaches that an oxygenated SiC antireflective film has the above-mentioned properties (see Angelopoulos, column 7, lines 45-60; column 8, lines 25-55), as well as the advantage of not reacting with the photoresist (see Angelopoulos, column 7, lines 45-50). Furthermore, since Angelopoulos shows that both SiC and SiCO films can be equivalently and interchangeably used (Angelopoulos, column 8, line 55-column 10, line 35), such that the oxygen content of the film is merely used to tune the index of refraction and extinction coefficient, it is well within the purview of a person skilled in the art to add oxygen to the antireflective layer of Bencher, in order to achieve this degree of tunability.

Regarding claims 2, 3, and 7, Bencher fails to specify the methodology of forming a SiCO-based film.

Angelopoulos discloses forming the SiCO-based film using gas or liquid sources of carbon, hydrogen, silicon, and oxygen (column 5, lines 35-42; column 9, lines 1-60; a

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methyilsilane is a source of carbon, hydrogen, and silicon), where the oxygen source is elemental oxygen (column 8, lines 38-40; column 9, lines 10-15), and where the ARL is formed in a high density plasma CVD reactor (column 9, line 65-column 10, line 3).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that the ARL in the method of Bencher as modified by Angelopoulos, *supra*, use the deposition methodology taught by Angelopoulos. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use high density plasma CVD and the specified source gases, because the Angelopoulos reference is the one that teaches formation of the oxygenated SiC film, and thus it would be apparent to use the specific methodology taught in Angelopoulos for the formation of the oxygenated SiC film.

Regarding claim 4, both Bencher and Angelopoulos disclose the use of silane as a precursor for forming the ARL (Bencher, column 8, lines 50-67; Angelopoulos, column 9, lines 1-60).

There is no teaching, however, as to the exact flow rates per square centimeter of the precursor.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify a silane flow rate of 0.01-0.5 sccm per square centimeter in the ARL method forming step of Bencher as modified by Angelopoulos. The rationale is as follows: A person having ordinary skill in the art would have been motivated to specify such a flow rate, because the selection of specific precursors and gas flows allows for the tunability of optical properties of the anti-reflective film, such as extinction coefficient and index of refraction (Angelopoulos, column 10, lines 5-11). Although Angelopoulos fails to specify flow rates for

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the gases, it has been held that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.”

In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955) (Also see Angelopoulos, column 10, lines 11-44).

3. Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Bencher et al. in view of Angelopoulos et al., as applied to claim 2, supra, and further in view of U.S. Patent No. 6,147,009 to Grill et al.

Bencher is silent as to applying radio frequency power in the CVD chamber.

Grill discloses applying radio frequency power in the chemical vapor deposition chamber (column 5, lines 18 – 55). Grill further discloses RF power intensities from 7 – 25W (column 5, lines 47 – 67), but fails to disclose the surface area of the anti-reflective layer.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the method of Bencher as modified by Angelopoulos, such that radio frequency power is applied in the chemical vapor deposition chamber, as taught by Grill, and such that the power intensity is from 0.05W – 5.5W per square centimeter of the surface of the anti-reflective layer. The rationale is as follows: One of ordinary skill in the art at the time the invention was made would have been motivated to select an RF power supply and the claimed power intensity ranges, because doing so aids in the deposition and optical property tuning of the SiCOH films (Grill, column 5, line 46 – column 6, line 24). Angelopoulos likewise teaches that the alteration of process parameters allows for the optimization of the extinction coefficient and index of refraction (Angelopoulos, column 10, lines 4 – 12). Although Bencher, Angelopoulos,

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and Grill do not specify power intensities per square centimeter of the coating, it has been held that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955) (Also see Angelopoulos, column 10, lines 11-44).

Response to Arguments

4. Applicant's arguments filed 4/5/05 have been fully considered but they are not persuasive.

“The Applicant first argues that one of skill in the art would not be motivated to oxygenate the SiC films of Bencher because Bencher *teaches away* from oxygenated SiC films. Bencher teaches a silicon carbide film having significant amount of carbon-bonded silicon species and thus a minimum amount of oxygen.” The Applicant further points to the spectrograph in figure 5 as evidence that the SiC film of Bencher does not have oxygen bonding, and further states that “Bencher discourages films containing significant amounts of oxygen.”

This is not persuasive, because in order to “teach away” from oxygenated SiC films, Bencher would need to either directly or implicitly make some sort of statement as to the undesirability or un-usability of oxygenated SiC films. Bencher, however, does not even address the usage of oxygenated SiC films, and hence, does not “teach away from” or “discourage” their usage. The Examiner maintains that since Bencher explicitly provides a listing of desired properties for the antireflective coating used in the dual damascene structure (see Bencher, table

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1, column 7, lines 20-45), any prior art anti-reflective layers that meet the listed properties would be reasonably combined with the teachings of Bencher.

The Applicant further argues that “contrary to the Examiner’s contention, nowhere does Angelopoulos teach or suggest that the oxygenated films have the properties Bencher describes as desirable for damascene or low-k materials” and “As far as desired optical properties, Bencher teaches that the preferred values of refractive index and absorption index at 248 nm exposure are 2.2 and 0.3-1.0, respectively... These are values that Angelopoulos teaches are most closely obtained with un-oxygenated SiC.”

This is not persuasive, because Angelopoulos does teach that the SiCH and SiCOH films have many of the desired properties cited by Bencher, such as high etch selectivity (Angelopoulos, column 7, lines 40-60), suitable n and k values to produce reflectance of less than 5%, as well as relative insensitivity of the reflectance to the antireflective layer thickness (see Angelopoulos, figure 4A), simple manufacturing process (see Angelopoulos, column 9), general stability and compatibility with photoresists (column 10, lines 45-60), and excellent resolution for 248 nm lithography (Angelopoulos, column 1, lines 25-40; column 10, lines 50-60). A person having ordinary skill in the art would understand that the specific n and k values desired for any specific application are selected based upon the optical properties of the underlying layers, such that reflectivity is minimized. Hence, a person skilled in the art would further find the SiCOH layer of Angelopoulos desirable in that the oxygen content and specific precursors used for the PECVD deposition allow for tunability of the n and k values (see Angelopoulos, column 6, lines 35-45), which permits minimization of the reflectance for a broad range of underlying materials, and thus increases the flexibility of the SiCOH layer.

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It is the Examiner's opinion that it is well within the purview of a person having ordinary skill in the art to select any of the prior art antireflective coatings known to be suitable for 248 nm lithography and have generally desirable anti-reflective properties, such as low reflectivity, high etch selectivity, and high tendencies not to poison the photoresist. Hence, using the SiCOH anti-reflective coatings taught by Angelopoulos for 248 nm lithography in place of the SiCH anti-reflective coatings of Bencher is an obvious substitution, based on the similar properties of both coatings, and based on the additional advantages taught by Angelopoulos, such as reduced reflectivity and enhanced tunability of the ARL. Alternatively, it would also be obvious to apply the anti-reflective coating of Angelopoulos to a dual damascene structure, as in Bencher, because Angelopoulos teaches that the SiCOH anti-reflective layer is suitable for etching a trench (see figures 10-11), and thus would be equally suitable for a dual damascene structure, which has similar etching and anti-reflection requirements as that of a single trench.

Conclusion

5. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event,

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however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.


Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Dolan whose telephone number is (571) 272-1690. The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl W. Whitehead, Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Jennifer M. Dolan
Examiner
Art Unit 2813

jmd


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